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MAGNETIC DIPOLE TRANSITION RATES IN DEFORMED ODD-A NUCLEI[†]; J. de Boer
and G. D. Symons, California Institute of Technology, Pasadena, California,
U.S.A.

Abstract: The ground state rotational bands of Eu^{153} , Tb^{159} , Dy^{163} ,
 Ho^{165} , Er^{167} , Lu^{175} and Hf^{177} have been studied by multiple Coulomb
excitation. The transition energies and the gamma ray branching ratios
for the decays of the second, third and fourth excited rotational levels
were determined. Assuming the theoretical values for the E2 transition
rates, the values of $B(\text{M}1)$ can be determined from the branching ratios.
There is an indication that, for the nuclei investigated here, the
absolute value of the rotational parameter $|\epsilon_K - \epsilon_R|$ increases with
increasing angular momentum.

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and O. D. Symons, California Institute of Technology, Pasadena, California,
U.S.A.

The E2 transitions in a rotational band are strongly enhanced and may therefore be expected to follow the intensity rules of the rotational model. The $B(M1)$'s for the cascade transitions in an odd-A nucleus have about single particle strength and are more sensitive to admixtures. In the present experiments, the magnetic dipole transition amplitudes have been determined for rotational transitions ($I \rightarrow I - 1$) from the crossover ($I \rightarrow I - 2$) to cascade ($I \rightarrow I - 1$) branching ratios assuming the E2 parts to be given by the rotational model. The rotational states have been reached by multiple Coulomb excitation.

Thin oxide targets of Eu^{153} , Tb^{159} , Dy^{163} , Ho^{165} , Er^{167} , Lu^{175} and Hf^{177} have been bombarded with oxygen ions of 18 to 42 MeV energy. The de-excitation gamma rays were recorded in coincidence with the backscattered oxygen ions. The following energies (in keV) have been determined for the rotational levels (spin assignment indicated in parentheses) in Eu^{153} : 83 ± 0.5 (7/2), 192 ± 1 (9/2), 324 ± 2 (11/2), 479 ± 3 (13/2), 662 ± 5 (15/2) and in Lu^{175} : 114 ± 1 (9/2), 252 ± 1 (11/2), 414 ± 3 (13/2), 602 ± 12 (15/2). The rotational energies of the ground state bands of the other nuclei are given in [1], [2] and [3].

The results are summarized in table I. The intrinsic quadrupole moment Q_0 (in units of 10^{-24} cm^2), taken from [4], is given in the first column below the symbol for each isotope. The crossover to cascade gamma

ray branching ratio for the decay of a rotational level with spin I is denoted by λ_I . The numbers in parenthesis indicate the errors in per cent. From the branching ratios λ_I , the values of $B(M1, I \rightarrow I - 1)$ have been determined, assuming the E2 parts to be given by the rotational model with the parameter Q_0 . The last column of table I gives the M1 transition rates, expressed in terms of the rotational parameters $|g_K - g_R|$ in units of $(e\hbar/2Mc)^2$. It can be noted that with increasing angular momentum the quantity $|g_K - g_R|_I$ increases by about 0.1 to 0.2 $(e\hbar/2Mc)^2$ per unit angular momentum for the nuclei investigated in the present experiments. It is believed that this effect is due to Coriolis admixtures from neighboring Nilsson states. The variation in Q_0 and g_K , arising from a possible increase of the nuclear deformation for higher angular momenta, is too small to account for the change in $|g_K - g_R|_I$.

References:

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Table I: Summary of experimental results and rotational parameters.

Isotope Q_0	I	λ_I	$ g_K - g_R $	Isotope Q_0	I	λ_I	$ g_K - g_R $
Eu ¹⁵³	9/2	2.39(15)	0.19(13)	Ho ¹⁶⁵	11/2	0.18(16)	0.72(10)
7.00	11/2	2.36(20)	0.37(12)	7.62	13/2	0.27(25)	0.89(14)
	13/2	1.08(60)	0.74(30)		15/2	0.38(50)	0.97(20)
Tb ¹⁵⁹	7/2	0.26(15)	1.04(10)	Er ¹⁶⁷	11/2	0.55(15)	0.33(15)
7.46	9/2	0.29(20)	1.58(15)	7.86	13/2	0.92(18)	0.40(15)
	11/2	0.54(50)	1.57(25)		15/2	0.59(60)	0.47(40)
Dy ¹⁶³	9/2	4.6 (15)	0.08(30)	Lu ¹⁷⁵	11/2	0.95(21)	0.33(15)
7.35	11/2	2.5 (22)	0.31(15)	7.52	13/2	1.07(35)	0.51(18)
	13/2	1.5 (80)	0.57(50)	Hf ¹⁷⁷	11/2	3.26(15)	0.09(35)
				6.74	13/2	6.60(60)	0.12(30)